(12) **EUROPEAN PATENT APPLICATION**

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(54) **Method for managing a network when master disappears**

(57) A method for managing a network in which Bluetooth equipped devices (300) are linked together when the network master (400) cannot serve as a master. During normal operation, the network master (400) updates the backup master rank information when the network master (400) disappears, in a predertimined cycle, according to link information, such as received signal strength indication (RSSI) or link quality, transmitted from the Bluetooth equipped devices serving as a slave. When power of the network master (400) is exhausted, or when the network master (400) leaves the network operating region, a new master is selected from the remaining slaves according to the backup master rank information, thereby reconfiguring a network around the new network master. The method enables proper designation of a new master when a preexisting network master (400) leaves the network operating region, thereby increasing a probability of holding connection throughout the network.

FIG.4
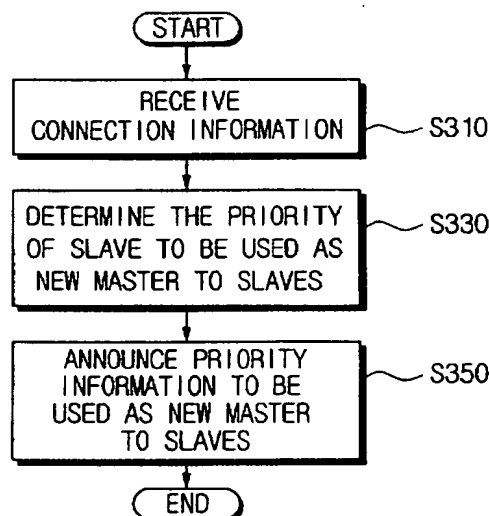
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lishing connections between the new master of the network and the remaining slaves, when a preexisting network master no longer remains in its role in the network at a point of time.

[0011] According to a first aspect of the invention, there is provided a method for building up backup master information, including the steps of (a) receiving connection information from at least one slave of a network; (b) determining a priority of a slave to be used as the backup master when a network master disappears, according to the connection information; and (c) announcing the determined priority information of the backup master to at least one slave.

[0012] The steps (a) through (c) are preferably repeated in a predetermined cycle.

[0013] The connection information may include received signal strength indication (RSSI) and/or link quality information.

[0014] In the step (b), a slave having higher RSSI is preferably given a higher priority, which is used to choose a new network master.

[0015] In step (b), a slave having higher link quality value may be given a higher priority for being chosen as a new network master.

[0016] The network is preferably a Personal Ad-hoc Network.

[0017] Step (c) may announce the determined priority information of a backup master to at least one slave through a broadcasting channel.

[0018] According to a second aspect of the invention, there is provided a method for designating a new master of a network when a preexisting network master disappears, including the steps of (a) determining whether the preexisting network master disappears; (b) if the preexisting network master disappears, determining a rank indicating an order for choosing the new network master, which is received before the disappearance of the preexisting network master; and (c) changing a role to the new network master, if the rank is the highest.

[0019] It is preferable that the step (d) of performing inquiry scan and page scan is provided.

[0020] The method for designating a new master of a network when a preexisting network master disappears preferably also includes the steps of (e) determining whether a new device attempts to establish a connection within the network; (f) accepting the request of the new device for connection, requesting the new device to change to a role as a slave, and remaining as the new network master; (g) storing information of the new device, and announcing the information of the new network master and each slave linked throughout the network, to each of the slaves linked throughout the network; and (h) checking for a change to the master mode if there is no connection request from a new device in step (e), returning to the step (d) when there is no change to the master mode, and terminating the master mode when there is a change to the master mode.

[0021] Preferably, in step (h), the change to the mas-

ter mode is determined when the role of the device serving as the network master is changed to a slave by a user, when the Bluetooth function of the master is switched off, or when power of the master is turned off.

[0022] The step (a) may include the sub-steps of (a1) checking a connection status with the preexisting network master; (a2) attempting to reconnect with the preexisting network master if disconnection is detected in sub-step (a1); (a3) checking whether reconnection with the preexisting network master is successful, and returning to the sub-step (a1) if the reconnection with the preexisting network master is successful; and (a4) determining the disappearance of the preexisting network master if reconnection with the preexisting network master is not established in sub-step (a3), and informing a host of the event as a "Disconnection Complete Event".

[0023] The sub-step (a1) is preferably repeated in a predetermined cycle, while the connection with the preexisting network master remains.

[0024] According to a third aspect of the invention, there is provided a method for establishing a connection between a new master and remaining slaves of a network when a preexisting network master disappears, including the steps of (a) checking whether the preexisting network master disappears; (b) checking backup master rank information, when determining the disappearance of the preexisting network master in step (a); (c) attempting to establish a connection with the new network master when determining non-highest priority, according to the backup master rank information; and (d) remaining as a slave if a connection with the new network master is established in step (c).

[0025] Methods according to embodiments of the present invention may thus enable proper designation of a new master when a preexisting network master leaves the network operating region, thereby increasing a probability of holding connection throughout the network.

[0026] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figure 1 is block diagram of a Bluetooth system capable of constructing a network;

Figure 2 is a flowchart illustrating a conventional method for designating a Bluetooth equipped device as the master or slave of a network;

Figure 3 illustrates the configuration of a network in which Bluetooth equipped devices are linked together;

Figure 4 is a flowchart illustrating a method for building up information on backup masters in a network,

received signal strength indication (RSSI) and/or link quality. The RSSI, which is measured by each slave and provided to the network master 400, is closely related to the distances between each of the network slaves 300 and the network master 400. The link quality information is an index of error rate in data transmission between the network master 400 and each slave, and is associated with the distance between the master 400 and each of the network slaves 300, and the presence or absence of obstructions therebetween. Network slaves 300 can read the RSSI value of a signal transmitted from the network master 400 using an HCI command, "Read-RSSI", prescribed in the Bluetooth standard. Network slaves 300 also get 1-byte numeric link information using a standard HCI command, "Get_Link_Quality". The higher the RSSI and link quality values, the better the connection status. The network master 400 determines the rank information of a backup master to be chosen as a new network master 400 when the preexisting network master leaves the network operating region, based on the connection information (S330). In the present embodiment, the rank information on the backup masters more likely to be chosen as a new network master is determined according to RSSI and/or link quality values. That is, a slave having higher RSSI and/or link quality values is given a higher rank as a backup master in order to be chosen as a new network master. This increases the probability of reconfiguring a network with the remaining slaves when a preexisting network master leaves the network operating region. After the rank of the backup master, which is used for choosing a new network master, is determined with respect to all the slaves in step S330, the network master 400 announces the rank information of the backup master determined in step S330, to each slave through a broadcasting channel (S350).

[0035] The network master 400 determines the new backup master rank information, which is used for choosing a new network master with respect to the slaves, every predetermined cycle, and announces the result to all of the network slaves 300. This is done in consideration of RSSI variations due to a change in location of the network master 400 and/or network slaves 300, and link quality variations due to, for example, the presence or absence of obstructions between the network master 400 and network slaves 300, or a change in other conditions.

[0036] Figure 5 illustrates the backup master rank information used for choosing a new network master with respect to the slaves in the network, which is determined by the method illustrated with reference to Figure 4. As shown in FIG 5, slave A 300a is designated as the fourth ranked backup master BACKUP 4, slave B 300b is designated as the first ranked backup master BACKUP 1, slave C 300c is designated as the second ranked backup master BACKUP 2, slave D 300d is designated as the third ranked backup master BACKUP 3, and slave E 300e is designated as the fifth ranked backup master

BACKUP 5. When power of the preexisting network master 400 is exhausted or the preexisting network master 400 leaves the network operating region, a network is reconfigured with the remaining network slaves 300 by designating a new master according to the rank information of the backup master more likely to be chosen as a new network master.

[0037] A method for reconfiguring a network when a preexisting network master leaves the network operating region will now be described with reference to Figures 6 through 9. After the rank information of the backup master more likely to be chosen as a new network master is determined as illustrated in Figure 5, each of the network slaves 300 A, B, C, D and E determines whether the preexisting network master 400 leaves the Network operating region (S410). Step S410 involves the sub-steps illustrated in Figure 7. The determination as to whether the preexisting network master 400 leaves the network operating region 250 is achieved by detecting a disconnection between the preexisting network master 400 and each of the slaves. According to the Bluetooth standard version 1.0, Bluetooth equipped devices monitor the mutual connection status every cycle, for example, in a period of 0.625 ms-40.9 sec, with a link supervision timer. Based on this, the network slaves 300 check their connection status with the network master 400 (S402). The cycle of monitoring the connection status with the network master can be determined according to the values of the link supervision timer. The network slaves 300 periodically check the connection status with the network master 400 using the link supervision timer. In step S402, if connections between the network master 400 and network slaves 300 are maintained, the network slaves 300 continue to monitor the connection status with the network master 400 every predetermined cycle. However, if a disconnection between the network master 400 and network slaves 300 is detected in step S402, a corresponding slave attempts to establish reconnection (S404). Next, the corresponding slave checks for whether reconnection with the network master 400 is established (S406). If yes, the process returns to step S402. In contrast, if reconnection between the network master 400 and the corresponding slave is not established, the corresponding slave determines the event as that the network master 400 left the network operating region, and informs the Bluetooth host of "Disconnection_Complete Event" (S408).

[0038] Referring back to Figure 6, when the absence of the network master 400 in the network operating region is identified, each of the slaves checks for backup master rank information, which is used to choose a new network master (S412). In step S412, each of the network slaves 300 checks for whether its rank is given the highest priority in order to be chosen as a new network master. If so, the corresponding slave changes its role to a new master (S415). The new master performs inquiry scan (S420) and page scan (S430). Next, the new

[0043] When the reconfiguration of a network is completed as mentioned above, optimization of transmission power between the new network master and the slaves is required. As previously mentioned, the method of building up priority information about a backup master for use in selecting a new master of a network when a preexisting network master disappears, the method for designating a new master according to the backup master rank information, and the method for establishing connections between a new master and remaining slaves, when a preexisting network master leaves the network operating region, increases a probability of holding connection throughout the network.

[0044] While this invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made thereto without departing from the spirit and scope of the invention as defined by the appended claims.

[0045] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0046] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0047] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0048] The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A method for building up backup master information, comprising the steps of:

   (a) receiving connection information from at least one of a plurality of slaves (300) in a network;

   (b) determining a priority of said at least one of

the plurality of slaves to be used as a backup master, when a network master (400) disappears, according to the received connection information; and

   (c) announcing the determined priority information of backup master (300b) to at least another one of the plurality of slaves.

2. The method of claim 1 or 2, wherein the steps (a) through (c) are repeated in a predetermined cycle.

3. The method of claim 1, wherein the received connection information includes received signal strength indication (RSSI) and/or link quality information.

4. The method of claim 3, wherein, in the step (b), if said at least one of the plurality of slaves has a higher RSSI than another one of the plurality of slaves, said at least one of the plurality of slaves is given a higher priority, which is used to choose a new network master.

5. The method of claim 3, wherein, in the step (b), if said at least one of the plurality of slaves has a higher link quality value than another one of the plurality of slaves, said at least one of the plurality of slaves is given a higher priority, which is used to choose a new network master.

6. The method of any preceding claim, wherein the network is a Personal Ad-hoc Network.

7. The method of any preceding claim, wherein in the step (c), the determined priority of the backup master is announced to the at least another one of the plurality of slaves, through a broadcasting channel.

8. A method for designating a new master of a network when a preexisting network master disappears, the method comprising the steps of:

   (a) determining whether the preexisting network master (400) has disappeared;

   (b) if the preexisting network master (400) has disappeared, determining a rank, which is used for choosing a new network master and is received before the disappearance of the preexisting network master (400); and

   (c) changing to a role as the new network master if the rank is highest of any one of a plurality of slaves.

9. The method of claim 8, after the step (c), further comprising the step (d) of performing inquiry scan
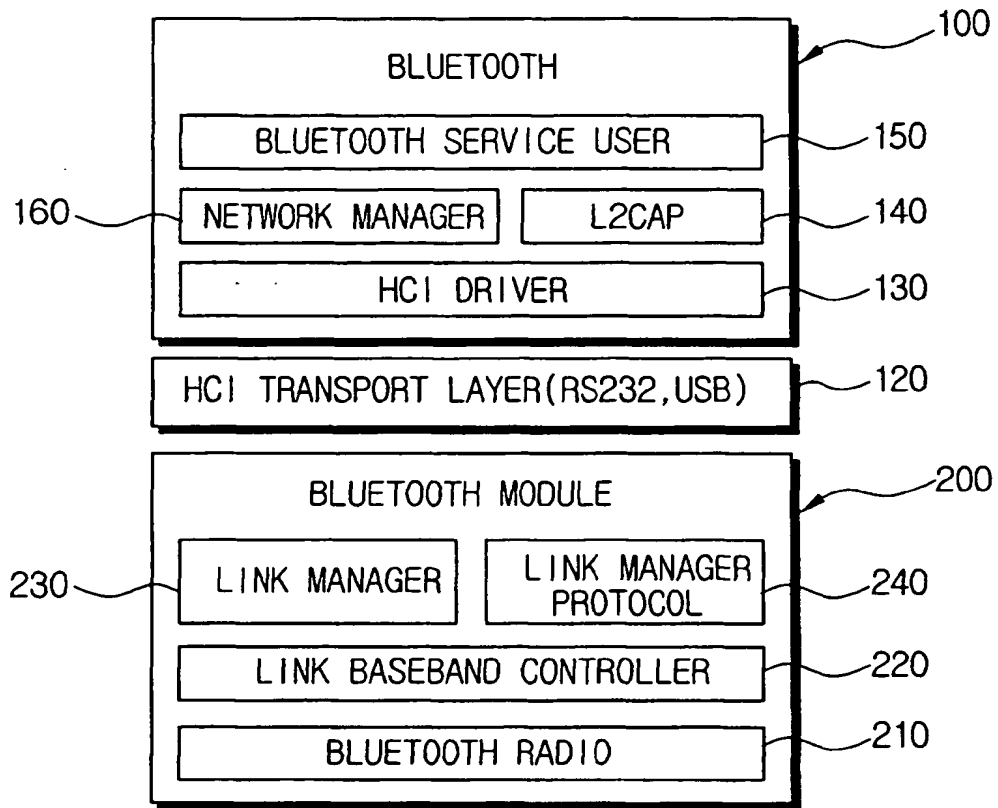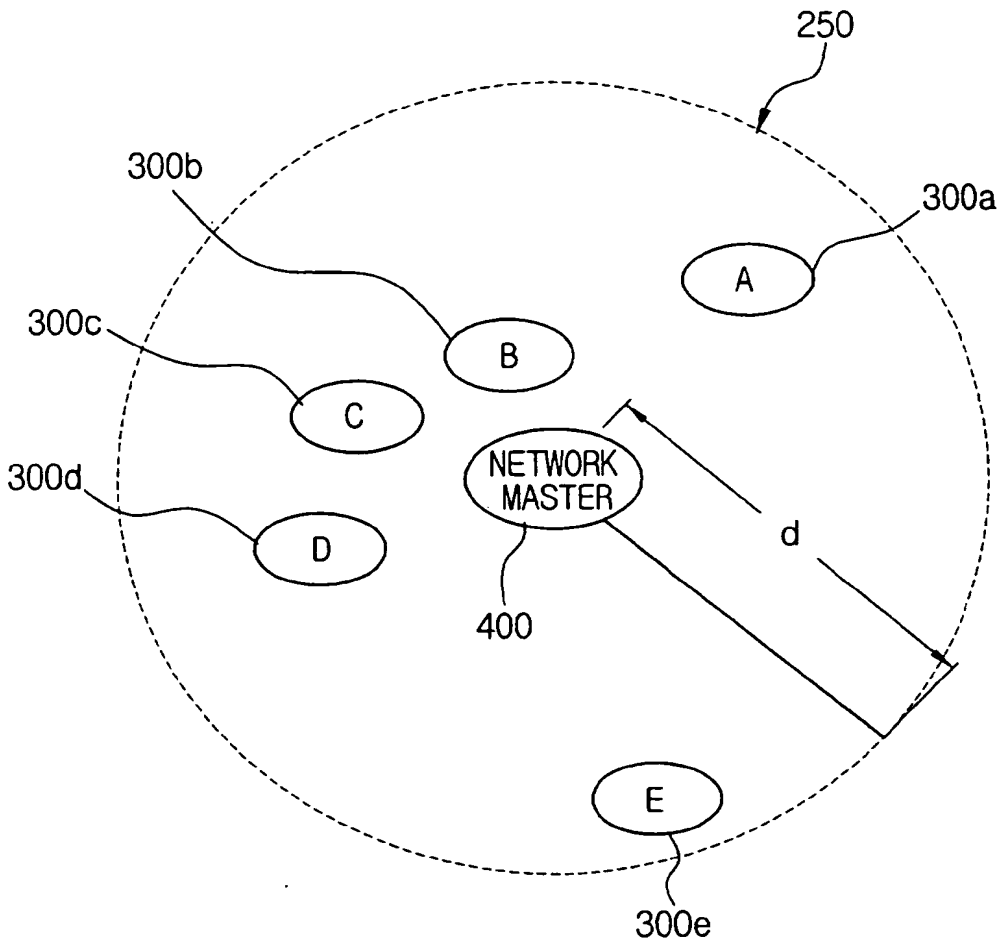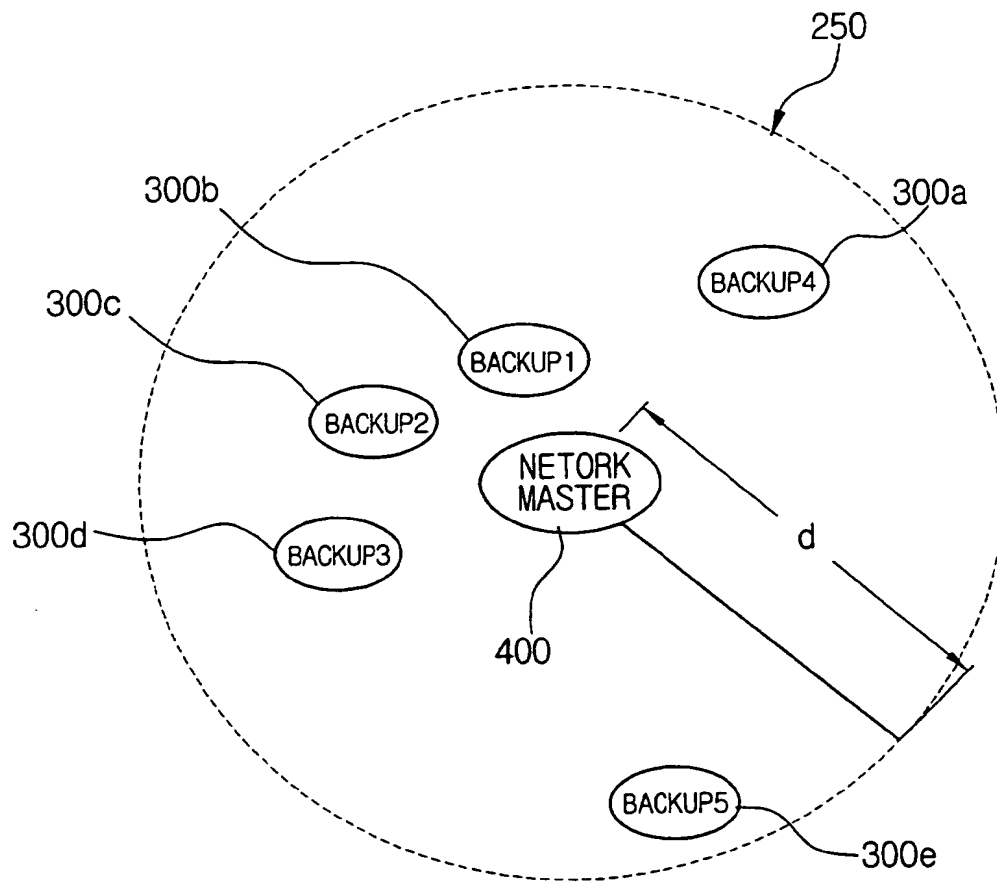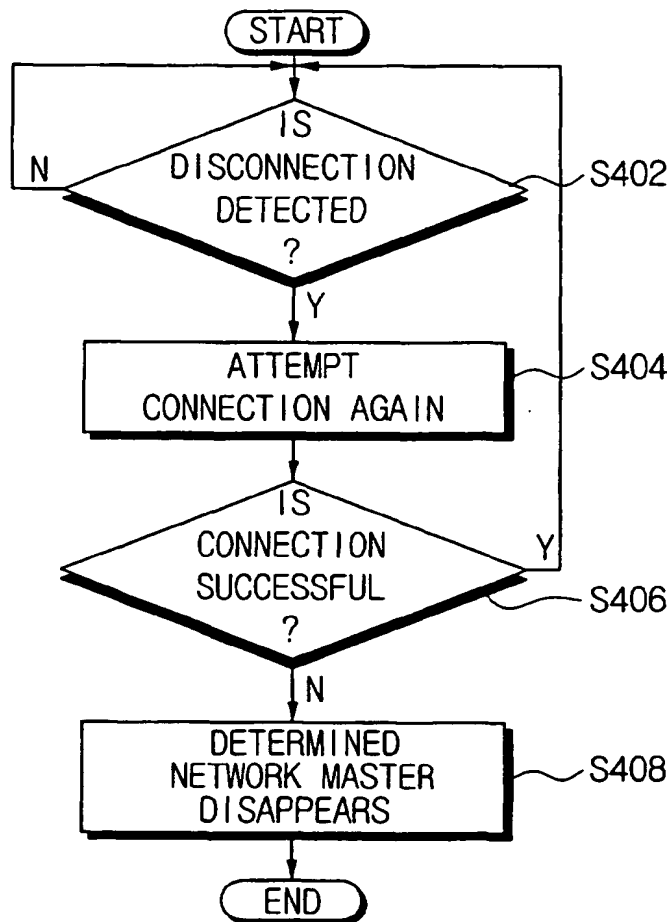
FIG.1

FIG.3

FIG.5

FIG.7

START

IS
DISCONNECTION
DETECTED
?   S402

N

Y

ATTEMPT
CONNECTION AGAIN   S404

IS
CONNECTION
SUCCESSFUL
?   S406

Y

N

DETERMINED
NETWORK MASTER
DISAPPEARS   S408

END

FIG.9

FIG.11

310e
310d
310c

BACKUP5

BACKUP4

BACKUP3 → NEW MASTER

600

NETWORK2

500
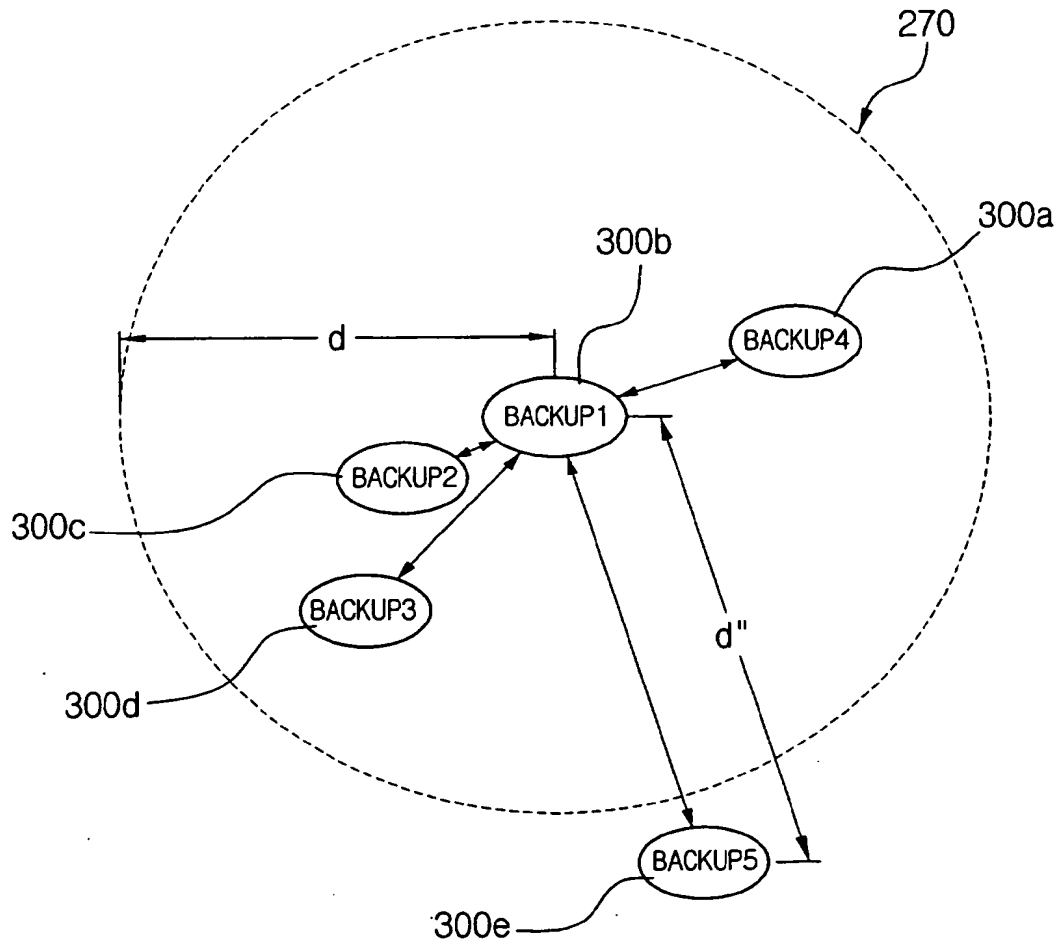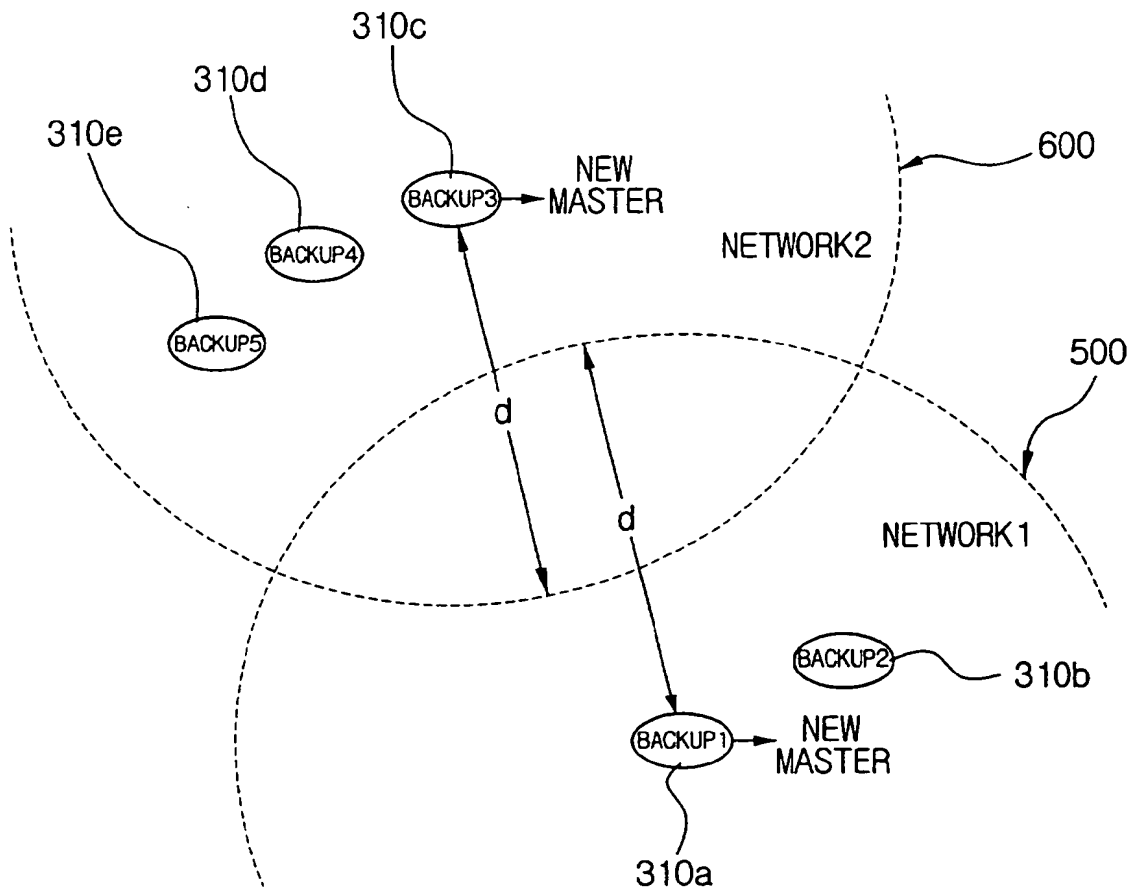
d

d

NETWORK1

BACKUP2 — 310b

BACKUP1 → NEW MASTER

310a

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 01 30 4435

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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15-08-2001

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 0103379	A	11-01-2001	DE	19930423 A	18-01-2001
			AU	6555600 A	22-01-2001

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